

Solar and Space Physics and the Vision for Space Exploration

Group E: Dosimetry and Human Effects

Program

Introduction

- A. Introductory Remarks: McKeever (NRC report; PEL NASA document; NCRP)
- B. Space Radiation Dosimetry for Human Exploration Missions...so far: Benton

Discussion Points (order TBD)

1. Given the current NASA timeline for the development of the Crew Exploration Vehicle (CEV), what can the scientific community realistically do to reduce or minimize the risk to crew from exposure to space radiation on the CEV?
 - CEV is planned to be operational no later than 2014, maybe as early as 2010. First human return mission to the Moon is planned for 2018. This means that the major design decisions for the CEV, including radiation detection instrumentation and radiation protection designs (e.g. radiation shielding materials and the placement of shielding) will be made in the next two to three years.
 - What are the major unanswered questions regarding human exposure to space radiation beyond the Earth's magnetosphere that will impact the near term Exploration effort?
2. How do we minimize the deleterious effects of a major SPE on crew should such an event occur during a Lunar or Mars mission? Possible approaches include:
 - shielding the whole of the habitable volume of the CEV;
 - including a storm shelter in surface habitats and in a Mars transfer vehicle;
 - shielding for the Lunar lander vs. fast abort capability;
 - use of *in situ* resources to shield a surface habitat.

How much shielding is needed to protect crew from SPE and how does this differ from the shielding needed to protect crew from exposure to GCR? What form (multifunctional material, atomic composition) should this shielding take?

3. How do we minimize the deleterious effects of GCR exposure on crew? Scenarios include:
 - EVA and Lunar/Martian surface exploration;
 - on board Luna/Martian Lander;
 - in habitat on Lunar/Martian Surface;
 - in CEV during Earth-Moon/Mars transit.

Possible approaches include:

- shielding the habitable volume of the CEV and Mars transfer vehicle;
- use of *in situ* resources to shield a surface habitat;
- for Mars missions, flying fast, i.e. using nuclear propulsion;

- for EVA or surface exploration, real-time active instrumentation and fast return to safe habitat.

4. What dosimetric data are still needed to accurately predict crew exposures on missions to and from the Moon and Mars?

- validation of space environment and radiation transport codes;
- SPE forecasting and nowcasting;
- measurements under realistic depths of shielding (simulating spacecraft walls and structure);
- measurements in tissue equivalent detectors;
- measurements during Lunar and Mars transfer, in Lunar and Mars orbit, and on Lunar and Martian surfaces;
- measurement of neutrons;
- measurement of GCR Z and E spectra.

5. What dosimetric instrumentation is needed to monitor crew exposure during Exploration missions?

- What quantities need to be measured and when (during the mission or after) is this information needed?
- How will instrumentation for dosimetry during SPE differ from that for dosimetry of GCR exposure?
- How much redundancy is needed, i.e. area monitors vs. personal dosimeters, active detectors vs. passive detectors, number of detectors based on different operating principles?
- Besides dosimeters to monitor crew exposure, what other radiation detection instrumentation is needed, e.g. internal vs. external detectors, alarmed detectors, neutron monitors, telescope/spectrometers, etc.?

6. How do we incorporate ALARA into Exploration Missions? What can we learn from NCRP-142?

7. What “model” SPE event should be used in guiding shielding design and mission planning? What energy range should we be looking at?